THE IMPACT OF SEASON OF BIRTH AND BREEDING OF BOARS OF POLISH LANDRACE BREED ON THEIR INSEMINATION EFFICIENCY

WPŁYW SEZONU URODZENIA I SEZONU EKSPLOATACJI ROZPŁODOWEJ KNURÓW RASY POLSKA BIAŁA ZWISŁOUCHA NA WYNIKI ROZRODU

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ABSTRACT

The effectiveness of breeding boars in insemination depends mainly on the skill of optimal use of their reproductive potential. Nevertheless, their semen is highly variable in its quality and physical characteristics, which makes it difficult to organise semen production for artificial insemination purposes. The present study contains an analysis of semen collected from Polish Landrace breed boars - the most popular pigs bred in Poland. It demonstrates that there is a statistically significant interaction between season of birth and reproductive season of Polish Landrace boars. What is more, it proves that these significant differences between reproductive performances of boars are closely connected to their breeding season and seasons of their birth and life. The results also illustrate how to improve organisation of insemination centres and make them better financially efficient.

Keywords: birth season, collection season, boar, breed, trait of ejaculate

STRESZCZENIE

Efektywność użytkowania rozpłodowego knurów zależy od umiejętności optymalnego wykorzystania ich potencjału rozrodczego. Jednak nasienie pobierane od knurów inseminacyjnych wykazuje dużą zmienność w zakresie parametrów fizycznych i jakościowych, co utrudnia właściwą organizację produkcji nasienia przeznaczonego do inseminacji. W przeprowadzonych badaniach wykazano statystycznie istotne współdziałanie sezonu urodzenia i sezonu użytkowania rozpłodowego w kształtowaniu wszystkich parametrów fizycznych nasienia knurów rasy polskiej białej zwisłouchej. Stwierdzone w badaniach istotne różnice między wynikami użytkowania rozpłodowego związane z sezonem urodzenia i eksploatacji rozpłodowej knura wskazują na konieczność uwzględnienia tych czynników w procesie selekcji. Uzyskane wyniki wskazują, że może to przynieść wymierne korzyści organizacyjno - ekonomiczne przyczyniające się do poprawy funkcjonowania stacji unasieniania loch.

Słowa kluczowe: sezon urodzenia, sezon pobierania nasienia, nasienie, rasa, cechy ejakulatów

DETAILED ABSTRACT

Celem badań była ocena wpływu sezonu urodzenia i sezonu eksploatacji rozpłodowej knurów inseminacyjnych rasy polskiej białej zwisłouchej na wyniki rozrodu. Materiał do badań stanowiło 37933 ejakulatów pozyskanych w latach 1994 – 2011 od 336 knurów rasy polska biała zwisłoucha użytkowanych w Małopolskim Centrum Biotechniki, Stacja Eksploatacji Knurów w Czerminie. Parametry ejakulatów knurów ocenianej rasy analizowano statystycznie w porach roku urodzenia i eksploatacji knura: wiosna, lato, jesień, zima. Analizę statystyczną przeprowadzono na podstawie obliczonych średnich arytmetycznych i odchyleń standardowych. W celu ustalenia różnic między grupami dwóch czynników zmienności (sezon urodzenia, sezon pobierania) wykonano dwuczynnikową analizę wariancji dla układu nieortogonalnego. Wnioskowanie statystyczne przeprowadzono przy dwóch poziomach istotność $p \leq 0.01$ i $p \leq 0.05$ obliczając Najmniejszą Istotną Różnicę – LSD.

W badaniach wykazano, że największą objętością ejakulatu wynoszącą średnio 280.61 cm^3 charakteryzowały się knury pochodzące z letniego sezonu urodzenia od których nasienie pobierano jesienią. Ponadto wykazano, że knury urodzone w sezonie jesiennym charakteryzowały się relatywnie wysoką i wyrównaną wartością wskaźnika koncentracji plemników we wszystkich sezonach eksploatacji. Dodatkowo ich nasienie wyróżniało się wysoką ogólną liczbą plemników o ruchu postępowym. W efekcie z jednego ejakulatu pozyskanego od tych knurów w sezonie wiosenny letnim i jesiennym produkowano średnio ponad 25 dawek a w sezonie zimowym ponad 26 porcji nasienia.

Jak wynika z przeprowadzonych badań parametry ilościowo - jakościowe nasienia knurów rasy polskiej białej zwisłouchej uzależnione były głównie od sezonu urodzenia knurów. Zmienność wynikająca z wpływu sezonu urodzenia knurów stanowiła od 45.90% (odsetek plemników ze zmianami podrzędnymi) do 72.96% (odsetek plemników o ruchu postępowym). Efekt sezonu urodzenia bardzo wyraźnie (67.64%) oddziaływał na koncentrację plemników. Z kolei sezon użytkowania rozpłodowego zaznaczył się zwłaszcza w odniesieniu do objętości ejakulatu (45.18%), ogólnej liczby plemników o ruchu postępowym (45.99%) i liczby dawek inseminacyjnych (43.89%).

INTRODUCTION

The effectiveness of breeding boars in insemination depends mainly on the skill of optimal use of their reproductive potential. Nevertheless, their semen is highly variable in its quality and physical characteristics, which makes it difficult to organise semen production for artificial insemination purposes. Important role in shaping of the parameters of boar semen, play both genetic and non-genetic factors (Banaszewska et al. 2007, Ciereszko et al. 2000, Kondracki 2010, Lapuste et al. 2011, Pokrywka, Tereszkiewicz 2011, Siemieniecka and Dybała 2006, Smital 2009). Among the variability factors of features of ejaculates also important are genetic race related effects (Adamiak et al. 2010, Kunowska-Slósarz and Makowska 2011, Muczyńska et al. 2010, Szostak 2003). Ejaculates obtained from breeders of different races differ in both semen volume and sperm concentration (Adamiak et al. 2010, Ciereszko et al. 2000, Milewska and Falkowski 2004, Muczyńska et al. 2010, Smital 2009, Szostak 2003, Szostak and Przykaza 2011).

The present study contains an analysis of semen collected from Polish Landrace breed boars - the most popular pigs bred in Poland (Kondracki 2010). Previous

studies (Muczyńska et al. 2010, Szostak 2008) indicate that boars of Polish Landrace breed have the best quality of semen when compared to other pure-race boars used for insemination in Poland. However it is important to mention, that the differences in the results of Polish Landrace Breed boars insemination efficiency are linked with season in which they are used for insemination purposes (Adamiak et al. 2010, Banaszewska et al. 2007, Ciereszko et al. 2000, Janett et al. 2005) and the season of their birth (Pokrywka et al. 2009). The differentiation in the quality of ejaculates, obtained in different seasons is one of the major organizational problems for insemination stations as it influences the number of sperm portions that are produced (Szostak 2008). According to Kondracki (2010) race of boar does not affect the quality of semen collected in various seasons. Ejaculates collected during autumn – winter season have the best qualitative and quantitative features. Impact of season of semen collection has on its characteristics can be explained mainly by two factors; changing length of the day in different seasons and temperature variations (Owsianny et al. 2004, Sancho et al. 2004, Smital 2009). According to Kondracki

(2010) seasonal changes in semen quality of boars are result of evolution and also because of close affinity of modern European pig breeds with wild boar, which is a species of the seasonal sexual activity. According to the authors (Owsianny et al. 2004) there is also a relationship between effects of use for insemination and the season when boars are born. These relationships were found both in pure race boars (Pokrywka et al. 2009) and in crossbreds (Pokrywka and Tereszkiewicz 2011).

The results of cited studies indicate that both the season of birth and the season of reproductive life strongly affect insemination efficiency of breeding boars. In the studies, an attempt was made to assess the significance of these factors on the physical parameters and quality of sperm collected from boars.

The aim of the study was to assess the impact of season of birth and breeding of boars of Polish Landrace breed on their insemination efficiency.

MATERIALS AND METHODS

The study material consisted of 37 933 ejaculates collected between 1994 -2011 from 336 of Polish Landrace breed boars farmed in Małopolska Biotechnology Centre, the Examination Station of Boars in Czermin. Ejaculates were collected manually from boars and marked with: volume of ejaculate not including spermatozoid fraction, percentage of progressive spermatozoids and concentration o spermatozoids; in accordance with procedures prescribed by Central Animal Breeding Station [1998]. The total number of progressive spermatozoids and number of insemination doses obtained from one ejaculate were calculated with use of system introduced by artificial insemination centre. The value of separate ejaculate was determined by multiplication of number of insemination doses from one ejaculate by the net price of one portion of sperm in 2012. The morphological evaluation of spermatozoids was conducted with use of specimen coloured with eosin and nigrosin, and then assessed in accordance with classification given by Blom (1981).

Features of ejaculates were analysed statistically in the seasons of birth and life of boar: spring (22 March to 21 June), summer (22 June to 21 September), autumn (22 September to 21 December), and winter (22 December to 21 March). The results were analyzed statistically with calculation of the arithmetic mean and standard deviation. In order to determine the differences between groups of two factors of variation (season of birth and actual season of collection) the two-way analysis of

variance ANOVA/MANOVA for non-orthogonal system was implemented. Statistical inference was carried out at two levels of significance: $p \leq 0.01$ and $p \leq 0.05$, with calculation of the least significant difference - LSD. All statistical calculations were performed with use of the STATISTICA 9.0 software.

RESULTS

Qualitative characteristics of ejaculates obtained from boars born and bred in various seasons of year are presented in Table 1. Studies have shown that semen collected during autumn from boars born in the summer season characterized with the highest volume of ejaculate - an average rate of 280.61 cm^3. The volume of ejaculate, obtained from these boars was about 18.31% higher when compared to the volume of ejaculate (Mean=237.19 cm^3) that was collected from boars born and bred in the spring. The ejaculates of a large volume were obtained from boars born in the summer and autumn, and the ejaculates of the smallest volume came from boars born in the spring. The correlation existed regardless of the operation season.

The research indicates that the semen with low ejaculates' number, collected from boars born in winter and spring characterized with a better sperm concentration rate, which was found especially during the spring and winter breeding seasons. The study also showed that boars born in the autumn season produced sperm with a relatively high level of concentration and this level was constant during all seasons of their life. As mentioned earlier boars born in the autumn season also produced a high volume of ejaculates and in addition, their semen characterized with a high total number of progressive spermatozoids (Table 1). Consequently, in average more than 25 doses of ejaculates were collected from boars in the spring, summer and autumn seasons and an average of more than 26 doses of ejaculates were collected during winter season (Table 1).

Boars born in the summer characterized with a high and constant (over 68%) indicator of the progressive spermatozoids in all seasons of their life. It should be noted that in case of boars born in other seasons the rate of progressive spermatozoids did not exceed 68% and ranged from 66, 77% (boars born in winter and used in the summer) to 67, 90% (boars born in winter and used in spring) . Conducted studies demonstrate a statistically significant influence of interaction between the season of birth and season of reproduction in the process of development of all the physical parameters of semen in Polish Landrace breed boars (Table 1).

At the same time, there was no significant interaction between the analyzed factors that could have impact on sperm morphological parameters (Table 1). It is worth noting that the largest number of major changing spermatozoids was found in the semen collected from boars born in the winter and used in summer (6.83%). In addition, semen collected from these boars also characterized with a significant percentage of sperm with subordinate changes. Further analysis of sperm morphological changes indicates that there were a high proportion of sperm cells with major changes in semen of boars born in the spring and used in autumn (4.09%).

Table 1. The impact of season of birth and breeding on the specification of semen of Polish Landrace Breed boars
Tabela 1. Wpływ sezonu urodzenia i sezonu eksploatacji rozpłodowej na cechy nasienia knurów rasy pbz

Trait Cecha	Season of birth (A) Sezon urodzenia (A)	Collection season - Sezon pobierania (B)								Interaction A x B Interakcja A x B	$NIR_{0,05}$	$NIR_{0,01}$
		Spring Wiosna		Summer Lato		Autumn Jesień		Winter Zima				
		Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Volume of ejaculates (cm^3) Objętość ejakulatu (cm^3)	Spring-Wiosna	237.19	88.26	246.51	83.01	266.88	93.01	241.21	94.24	**	4.89	7.04
	Summer-Lato	256.67	101.35	261.49	102.63	280.61	97.31	275.34	100.91			
	Autumn-Jesień	261.01	87.71	267.32	98.95	275.99	102.59	272.53	96.79			
	Winter-Zima	241.21	94.71	258.85	98.65	268.34	105.84	248.44	96.03			
Percentage of progressive spermatozoids (%) Odsetek plemników o ruchu postępowym (%)	Spring-Wiosna	67.41	6.56	66.95	6.41	67.22	6.01	67.38	6.07	**	0.31	0.44
	Summer-Lato	68.53	5.01	68.22	6.15	68.04	5.91	68.51	4.19			
	Autumn-Jesień	67.92	5.29	67.42	6.53	67.81	5.52	67.28	6.55			
	Winter-Zima	67.91	5.93	66.77	7.63	66.99	6.46	67.37	6.89			
Concentration of spermatozoids ($x10^6/cm^3$) Koncentracja plemników ($x10^6/cm^3$)	Spring -Wiosna	452.65	137.16	442.97	133.34	431.81	129.43	446.21	125.66	**	7.08	10.17
	Summer-Lato	436.96	146.61	439.92	144.95	437.58	135.17	437.97	139.49			
	Autumn-Jesień	455.99	146.12	444.42	131.53	446.67	133.81	450.84	142.58			
	Winter-Zima	471.25	152.85	453.58	142.27	447.13	142.51	468.22	147.57			

Total number of progressive spermatozoids ($x10^9$) Ogólna liczba plemników o ruchu postępowym ($x10^9$)	Spring-Wiosna	70.77	23.36	71.77	22.51	75.67	22.91	73.83	23.93	**	1.19	1.71
	Summer-Lato	72.58	23.95	74.58	24.36	81.98	25.77	79.24	26.33			
	Autumn-Jesień	76.51	22.27	76.56	23.47	78.72	23.31	79.48	24.05			
	Winter-Zima	75.25	22.58	77.07	22.38	78.41	24.56	77.81	23.44			
Number of insemination doses (Pcs.) Liczba dawek inseminacyjnych (szt.)	Spring-Wiosna	23.43	7.42	23.73	7.11	25.01	7.26	24.34	7.62	**	0.41	0.57
	Summer-Lato	24.11	7.81	24.66	7.73	27.02	8.12	26.07	8.34			
	Autumn-Jesień	25.39	7.15	25.32	7.41	25.99	7.37	26.21	7.66			
	Winter-Zima	24.99	7.23	25.59	7.06	25.99	7.73	25.77	7.49			
The percentage of spermatozoids with major changes (%) Odsetek plemników ze zmianami głównymi (%)	Spring-Wiosna	2.68	1.85	2.38	1.81	4.09	1.13	1.34	0.98	NS	0.57	0.82
	Summer-Lato	0.89	0.66	1.21	0.53	0.41	0.25	0.43	0.29			
	Autumn-Jesień	3.11	2.21	3.09	2.07	1.86	1.31	3.68	2.79			
	Winter-Zima	3.01	1.79	6.83	3.92	2.38	0.91	3.55	2.98			
The percentage of spermatozoids with subordinate changes (%) Odsetek plemników ze zmianami podrzędnymi (%)	Spring-Wiosna	2.97	2.17	2.77	1.15	3.61	2.41	2.05	1.58	NS	0.63	0.83
	Summer-Lato	1.87	1.35	2.12	1.94	1.24	0.17	1.65	0.23			
	Autumn-Jesień	6.82	3.52	4.69	2.47	4.93	2.27	1.97	0.81			
	Winter-Zima	4.61	2.74	6.02	1.71	3.16	1.91	3.12	1.51			

** difference significant at P ≤ 0.01; NS - difference not significant -** różnica istotna przy P ≤ 0.01; NS - różnica nieistotna

The subordinate changes in high frequency spermatozoids of sperm were found in the semen of boars born in the autumn and used in spring, summer and autumn season (Table 1).

The commercial value of doses obtained from boars of Polish Landrace breed, expressed in PLN, with description of their season of birth and season when the samples were collected is presented in (Fig 1). Commercial value of ejaculates, collected from Polish Landrace Breed, taking into account the season of their birth and life, fluctuated from 469 PLN for ejaculates of boars born and used in the spring season to 534 PLN for ejaculates of boars born in the summer and used for insemination purposes in the autumn season. The ejaculates collected from boars born and used for insemination purposes in the spring season achieved an average rate of 469 PLN. The highest commercial value (an average of 534 PLN) was achieved by ejaculates obtained from boars born in the summer and used for insemination in the autumn season. It is worth noting that the value of boar semen doses collected from boars born in the spring season regardless of the insemination season, did not exceed the value of 500 PLN. While in the same time, the value of ejaculates collected from boars born in autumn and winter, in any season of operation, exceeded value of 500 PLN. There is also to be noted, a clear tendency of growth in the value of boar semen regardless of the season of birth of boars collected in the autumn – winter season (Fig 1).

Studies have shown that the qualitative and quantitative parameters of semen collected from Polish Landrace breed mainly dependent on the season of their birth. The variability resulting from the impact of season in which the boars are born fluctuated from 45.90% (the percentage of spermatozoids with subordinate changes) to 72.96% (the percentage of progressive spermatozoids). The impact of season of birth strongly affected the sperm concentration (67.64%). However, it should be noted that the season when breeding boars from Polish Landrace breed were used for insemination had also a relatively high share in formation of general volatility in the parameters of analyzed semen. The influence of season of reproduction of boars is particularly visible when linked with the volume of ejaculate (45.18%), the total number of progressive spermatozoids (45.99%) and the number of insemination doses (43.89%) (Fig 2).

DISCUSSION

Despite the long process of domestication a full control of the factors causing seasonal changes in semen quality has not been achieved. According with Banaszewska et al. (2007), and Siemieniecka and Dybała (2006) seasonal changes in semen quality are observed regardless of the genetic factors associated with race of boars. Significant seasonal changes in sperm parameters are also found in boars of Polish Landrace breed and are associated both with the reproductive season (Adamiak et al. 2010, Milewska and Falkowski 2004, Pokrywka and Ruda 2004) and season of birth (Pokrywka et al. 2009). Previous observations have also been confirmed in the presented study. The best quality indicators, expressed by the volume of semen ejaculate, sperm concentration and a number of spermatozoids in the semen were found in semen of boars born in the autumn and used for reproduction in the autumn/winter season. A significant reduction of results,

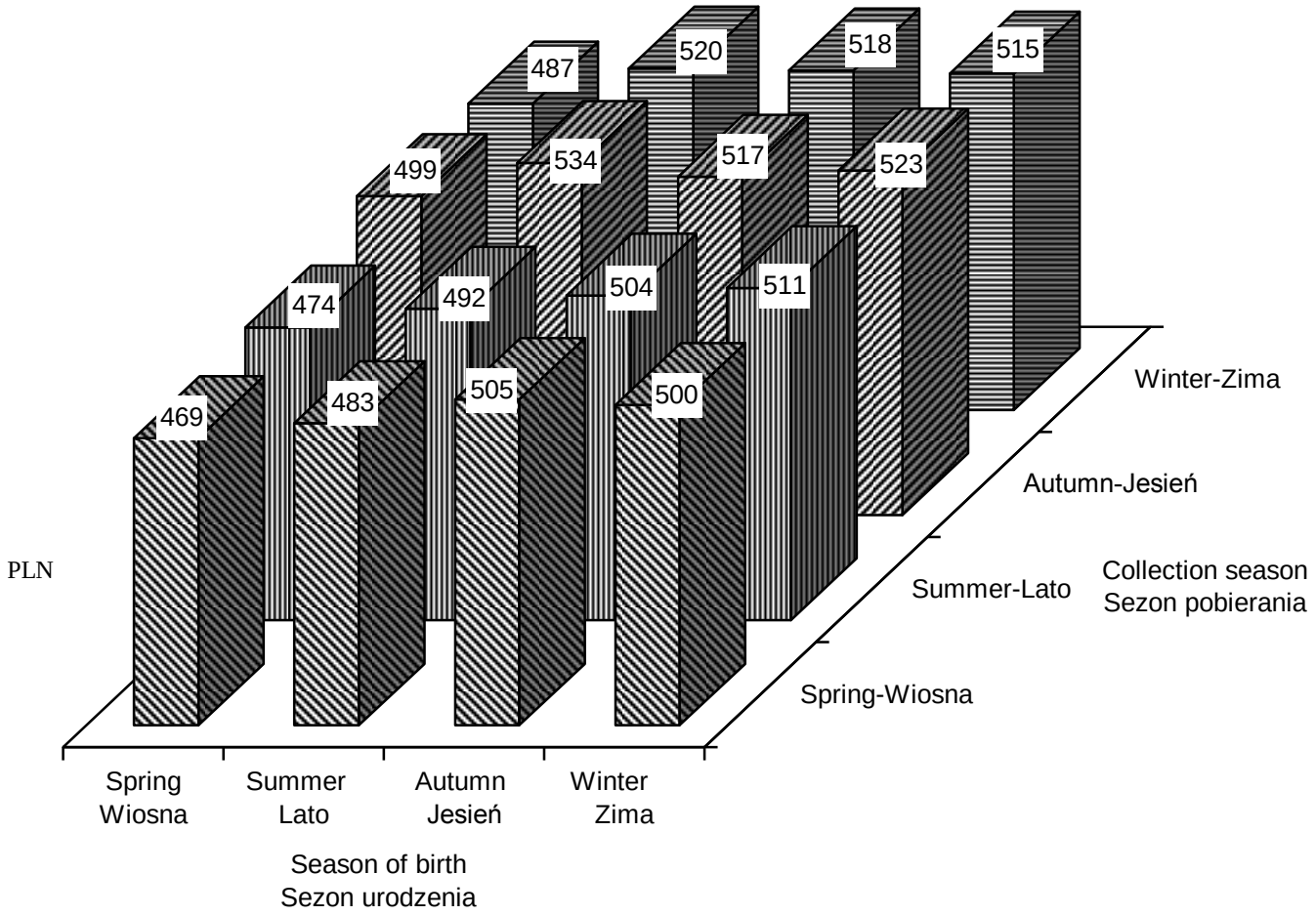

Figure 1. The impact of season of birth and season of breeding of Polish Landrace breed on the value of one ejaculate.
Rysunek 1. Wpływ sezonu urodzenia i sezonu eksploatacji rozpłodowej na wartość jednego ejakulatu knurów rasy pbz

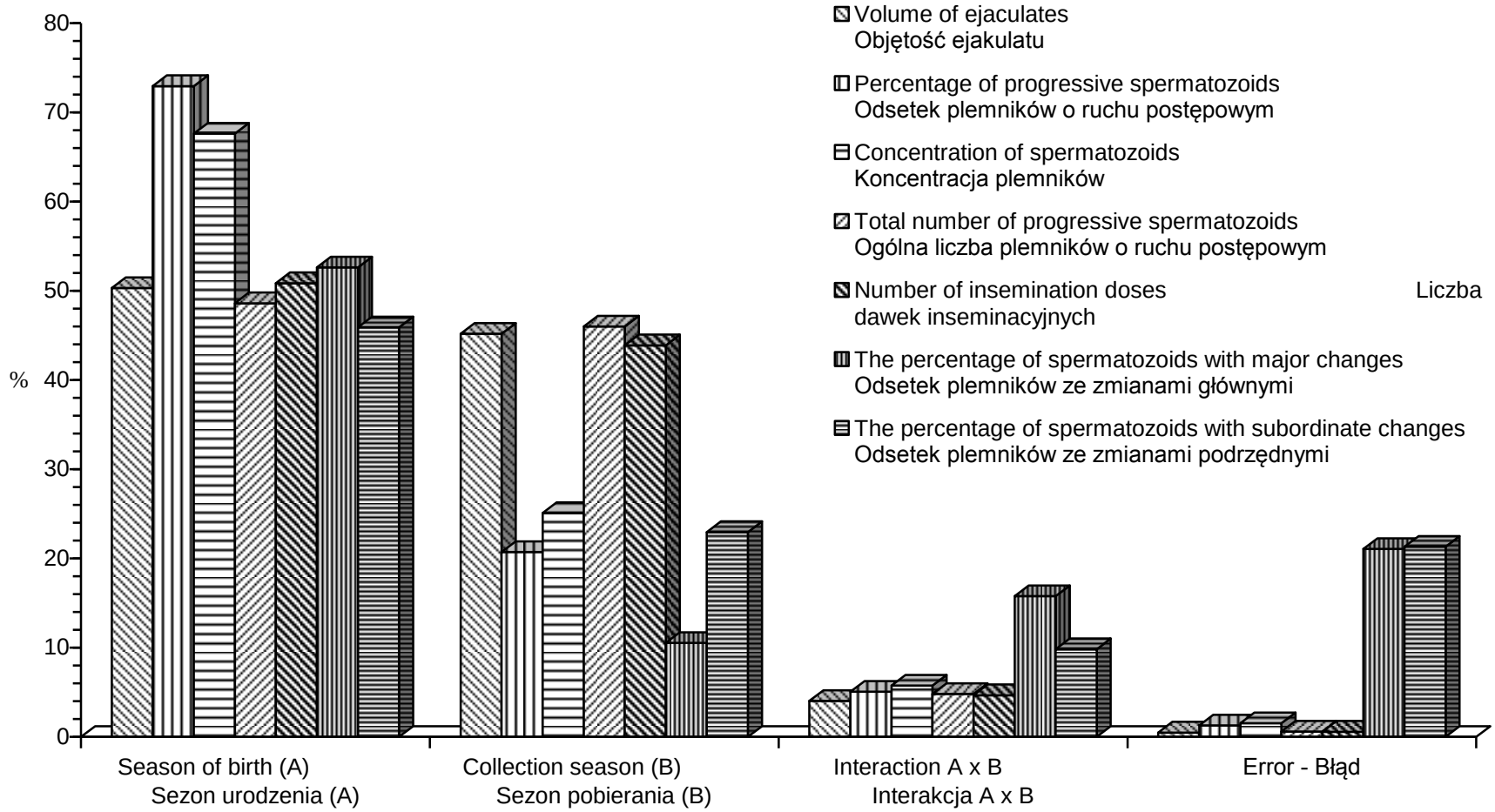

Figure 2. The impact of season of birth and season of breeding in shaping of parameters of the sperm collected from Polish Landrace breed boars (the average squared deviations are expressed in % of their total number)

Wykres 2. Udział sezonu urodzenia i sezonu pobierania w kształtowaniu parametrów nasienia knurów rasy pbz (średnie kwadraty odchyleń w % ich sumy)

expressed with reduced volume of ejaculates obtained from boars, was observed in case of boars born in the spring. It is worth noting that the boars born in spring produced the smallest volume of ejaculates in all seasons of operation (Table 1). Earlier studies (Adamiak et al. 2010) indicate that in the spring season (April to June) boars from Polish Landrace breed produce the lowest volume of semen in addition with a low sperm concentration. Milewska and Falkowski (2004) found that boars of Polish Landrace breed produce the smallest volume of ejaculates with highest spermatozoid concentration in the spring season. Similar results were obtained by Pokrywka and Ruda (2004). In other studies on the impact of season of birth on semen quality of boars from Polish Landrace breed, it was found that the lowest qualitative and quantitative parameters had semen obtained from boars born in the spring (Pokrywka et al. 2009). Simultaneously best results were achieved by boars born in autumn and winter.

The number of insemination doses produced from one portion of sperm is determined by the volume and concentration of sperm (Siemieniecka and Dybała 2006). According to Muczyńska et al. (2010) Polish Landrace breed boars characterize with a high quality of ejaculates, expressed in a high sperm concentration and high percentage of progressive spermatozoids; which allows for production of a great number of sperm servings. The mentioned authors confirmed that the average number of insemination doses obtained from one ejaculate of Polish Landrace Breed boars was 28.21 (data for 1996 - 2007). In previous studies (Kondracki and Banaszewska 1999) it was showed that a single ejaculate of boars from Polish Landrace breed produces an average of 25.99 doses of semen. According to Szostak (2003) only 21.75 portions of semen can be produced from one ejaculate of Polish Landrace breed boars. The research shows that the number of insemination doses that are produced remains under a significant influence of factors related to the breeding season (Pokrywka and Ruda 2004, Siemieniecka and Dybała 2006, Szostak 2003). It was found that the greatest portion of semen may be obtained during autumn and winter seasons (Adamiak et al. 2010). Similar results were gained by (Pokrywka and Ruda 2004). According to Pokrywka and Tereszkiewicz (2009) a number of produced insemination doses also depend on the season when boars are born. Best results are here gained by Polish Landrace breed boars born in the winter (Mean=25.66 portions).

The results of numerous studies (Ciereszko et al. 2000, Janett et al. 2005, Jankevičiūtė and Zilinskas 2002, Pokrywka et al. 2009, Okere et al. 2005, Owsianny et al. 2004) with reference to the impact of season of birth and season of use on breeding efficiency suggest that these factors significantly determine sperm production in boars. In the present study attempts to assess their mutual aid in the development of insemination boars' semen parameters were taken. The study showed that there is a high statistical interaction between season of birth and season of boar's reproductive life in the process of sperm formation with the only exception of its morphological characteristics (Tables 1). As it was found, the largest part in the improvement of quantitative and qualitative parameters of semen collected from boars of assessed race took the season of birth that influenced mainly the total number of spermatozoids in the sperm and percentage of progressive spermatozoids. The impact of the season was also marked by the volume of the ejaculate and total number of progressive spermatozoids. (Fig. 2).

CONCLUSIONS

The study demonstrates that there is a statistically significant interaction between season of birth and reproductive season of Polish Landrace boars. As it was presented, the highest procreative potential, expressed by the physical indicators, the quality of sperm produced and also by the value of insemination doses was found in boars of Polish Landrace Breed born in the autumn and used for reproduction purposes in the autumn-winter season.

What is more, these significant differences between reproductive performances of boars are closely connected to their breeding season and seasons of their birth and life, which indicates that these factors should also to be taken into consideration during the selection process. The results also illustrate how to improve organisation of insemination centres and make them better financially efficient.

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